World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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From Silos to Synergy: How supply chain integration drives organizational performance in Nigeria's renewable energy sector

Yetunde Esther Aderomola *

Newcastle Business School, Northumbria University, United Kingdom.

World Journal of Advanced Research and Reviews, 2026, 31(03), 194–203

Publication history: Received on 19 May 2026; revised on 01 July 2026; accepted on 03 July 2026

Article DOI: https://doi.org/10.30574/wjarr.2026.31.1.1833

Abstract

Purpose: Nigeria's renewable energy sector is expanding rapidly, yet fragmented supply chains continue to constrain the operational and service-delivery performance of firms within it. This study examines the effect of four dimensions of supply chain integration (SCI); internal, supplier, customer, and strategic; on the organisational performance of renewable energy firms in Lagos State, Nigeria.

Design/methodology/approach: A quantitative, positivist, cross-sectional design was adopted. Structured questionnaires were administered to 100 employees and managers drawn from two renewable energy organisations operating four branches across Lagos State. Data were analysed using descriptive statistics, Pearson correlation, and simple linear regression in SPSS 23, informed by a resource-based view (RBV) and contingency-theory framework.

Findings: All four hypotheses were supported. Internal integration explained the largest share of variance in organisational performance (R^2 = .816), followed by overall/strategic integration (R^2 = .733), supplier integration (R^2 = .662), and customer integration (R^2 ≈ .663). Real-time data sharing, open supplier communication, and cross-departmental alignment were the most strongly endorsed integration practices (mean ratings above 4.0 on a 5-point scale).

Originality/value: While SCI–performance relationships are well documented in manufacturing, banking, and general service contexts, empirical evidence from Nigeria's renewable energy sector remains scarce. This paper extends SCI theory into an emerging-market energy context shaped by infrastructural and regulatory constraints, and offers practical guidance for managers and policymakers seeking to strengthen integration practices.

Keywords: Supply Chain Integration; Organizational Performance; Renewable Energy; Internal Integration; Supplier Integration; Customer Integration; Lagos State Nigeria

1. Introduction

The global energy landscape is undergoing a decisive shift towards renewable sources, driven by climate commitments, energy-security concerns, and the falling cost of clean-energy technologies. Nigeria, Africa's largest economy, has embraced this transition as part of a strategy to diversify an energy mix historically dominated by fossil fuels and to close a persistent electricity access gap (World Bank Group, 2021). Lagos State, as the country's commercial nerve-centre, hosts a growing cluster of solar, wind, and hybrid renewable energy firms serving both grid and off-grid customers. The performance of these firms depends not only on the technologies they deploy but on how effectively they organise the flow of materials, information, and decisions across their supply chains.

* Corresponding author: Yetunde Esther Aderomola

Supply chain integration (SCI); the extent to which a firm coordinates internal functions and collaborates with suppliers and customers to align processes, information, and strategy; has been consistently linked to superior operational and financial performance in manufacturing, banking, and general service industries (Flynn, Huo, and Zhao, 2010; Cousins, Lawson, Petersen, and Fugate, 2019; Kotzab, Bäumler, and Gerken, 2023). Yet renewable energy organisations in Nigeria continue to report fragmented supply chains, weak supplier collaboration, and limited cross-functional coordination, despite the sector's strategic importance to national energy diversification (Eltayeb, Elkadi, and Ali, 2021). This mismatch between the recognised value of SCI and its uneven application in Nigeria's renewable energy sector constitutes the empirical problem this study addresses.

Prior SCI research has concentrated overwhelmingly on manufacturing and financial-services settings (Jacobs, Swink, and Linderman, 2021; Munir, Jajja, Chatha, and Farooq, 2020), leaving the renewable energy sector of emerging economies comparatively under-examined. Where energy-sector studies exist, they rarely disaggregate SCI into its constituent dimensions or test their differential effects on performance within a single, coherent model (Jones et al., 2021; Smith and Autry, 2022). This paper responds to that gap by examining, empirically, how four dimensions of SCI; internal, supplier, customer, and strategic integration; affect the organisational performance of renewable energy firms in Lagos State.

Accordingly, the study pursues four objectives: (i) to assess the effect of internal integration on operational efficiency; (ii) to examine the effect of supplier integration on energy output and capacity utilisation; (iii) to analyse the effect of customer integration on customer satisfaction; and (iv) to evaluate the overall effect of strategic/overall SCI on operational performance and service delivery. The remainder of the paper is organised as follows: Section 2 reviews the conceptual and theoretical literature and develops four hypotheses; Section 3 details the methodology; Section 4 presents the results; Section 5 discusses the findings; and Sections 6 and 7 conclude with recommendations, implications, and limitations.

2. Literature review

2.1. The Concept of Supply Chain Integration

Supply chain integration is broadly understood as the degree to which a firm strategically collaborates with its supply chain partners and manages both internal and external processes to achieve a smooth flow of materials, capital, information, and decisions, ultimately to serve customers effectively (Abdallah, Alfar, and Alhyari, 2021). Johono and Siagian (2022) similarly frame SCI as encompassing procurement, production, distribution, and customer-facing processes, while Wong, Sinnandavar, and Soh (2021) describe it as the coordinated flow of materials and goods alongside capital and information across a supply network. Cousins et al. (2019) add that SCI capability is built cumulatively through complex interactions between a firm and its network partners, enabling resource allocation that benefits suppliers, customers, and the firm simultaneously. Kotzab, Bäumler, and Gerken (2023) synthesise these views, defining SCI as the extent to which a business manages intra- and inter-organisational operations through coordinated planning, information sharing, operational coordination, and strategic partnership. Consistent with Flynn, Huo, and Zhao's (2010) foundational definition, this study conceptualises SCI along four dimensions — internal, supplier, customer, and strategic (overall) integration — each theorised to influence organisational performance through a distinct mechanism.

2.2. Internal Integration and Operational Efficiency

Internal integration refers to the alignment of processes, systems, people, and information across a firm's internal functions (Fernandez and Hazen, 2021). Internal integration is widely regarded as a precondition for effective external integration, because it establishes the cross-functional visibility on which supplier and customer collaboration depend (Ivanov and Dolgui, 2020). Firms that dismantle functional silos and enable real-time information sharing between procurement, production, and distribution report reduced downtime, faster response to market changes, and more efficient resource use (Wang, Cao, Bai, Jia, and Li, 2020; Melnyk et al., 2020). Technological enablers — cloud platforms, data analytics, and automation — further support operational efficiency by streamlining routine tasks and improving demand forecasting (Laudon and Laudon, 2016), while organisational culture and leadership shape the extent to which such integration is embraced in practice (Cameron and Quinn, 2019).

2.3. Supplier Integration and Capacity Utilisation

Supplier integration involves collaborative planning, shared forecasting, and coordinated production between a firm and its upstream partners (Jacobs, Swink, and Linderman, 2021). Vendor-managed inventory and joint demand planning have been shown to reduce stock-outs and improve order fulfilment (Govindan, Cheng, Mishra, and Shukla,

2020), while trust and long-term supplier commitment underpin the sustained collaboration needed for capacity optimisation (Jacobs et al., 2021; Srai and Lorentz, 2020). Because renewable energy technologies (solar panels, inverters, storage systems) frequently rely on imported components, supplier integration is particularly consequential for capacity utilisation in this sector, where supply disruptions translate directly into idle production capacity (Demerouti, Bakker, and Halbesleben, 2020; Brynjolfsson and McAfee, 2017).

2.4. Customer Integration and Customer Satisfaction

Customer integration captures the extent to which firms incorporate customer feedback, preferences, and behavioural data into product, service, and operational decisions (Wu, Liu, and Zhong, 2021). Data-driven personalisation and structured feedback loops enable firms to anticipate and respond to shifting customer expectations, which in turn strengthens satisfaction and loyalty (Li, Liu, Zhang, and Li, 2020). In energy markets, where service reliability and responsiveness are key differentiators, systematic use of customer feedback to refine service-delivery processes is theorised to have a direct bearing on satisfaction outcomes.

2.5. Strategic (Overall) Integration and Performance Outcomes

Strategic integration refers to the alignment of supply chain objectives with a firm's broader strategic goals, ensuring that internal, supplier, and customer integration efforts operate coherently rather than in isolation (Beske and Seuring, 2023). Digital technologies increasingly enable this alignment by improving data visibility across the supply chain and supporting more informed strategic decisions (Chen, Zhao, and Han, 2022). In the Nigerian context, where firm performance is additionally shaped by managerial capability, market orientation, and the wider regulatory and institutional environment (Olusegun, Adeyeye, and Agwu, 2021; World Bank Group, 2021), strategic integration is theorised to be the mechanism through which internal, supplier, and customer integration jointly translate into measurable gains in operational performance and service delivery.

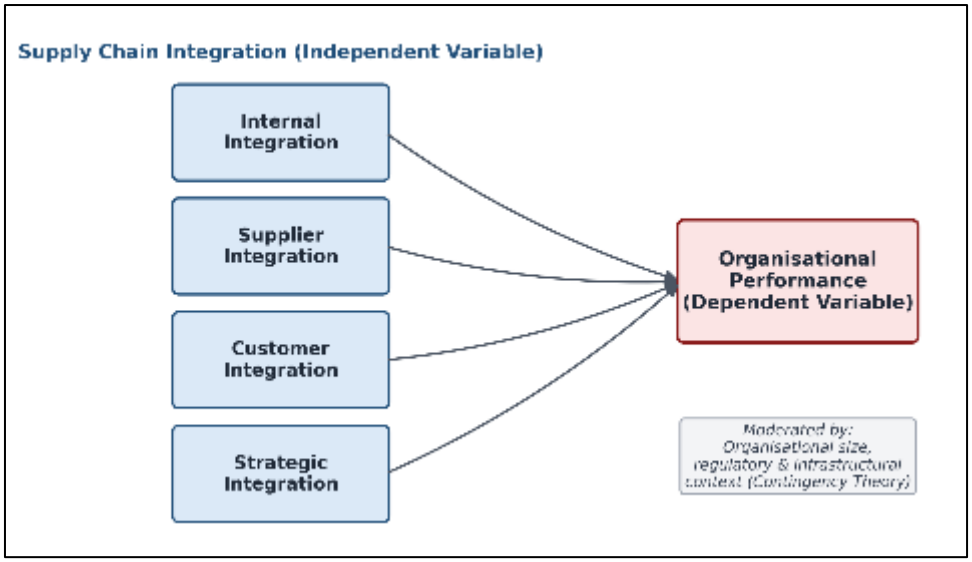
2.6. Theoretical Framework

Two theories underpin this study. The resource-based view (RBV) holds that a firm's sustained competitive advantage derives from resources and capabilities that are valuable, rare, and difficult to imitate (Madhani, 2010). Applied to SCI, RBV suggests that integration capabilities — technology, information systems, and relational assets with suppliers and customers — constitute firm-specific resources that renewable energy organisations can leverage for competitive advantage, particularly given Nigeria's challenging infrastructural environment. Complementing RBV, contingency theory holds that there is no single best way to organise a supply chain; the effectiveness of SCI depends on contextual factors such as firm size, industry dynamics, geographic scope, and regulatory environment (Molina-Azorin, Tarí, Pereira-Moliner, López-Gamero, and Pertusa-Ortega, 2020). Within renewable energy specifically, larger firms tend to pursue vertical integration to secure specialised inputs, while smaller firms rely more heavily on collaborative supplier networks (Carvalho, Ramos, Vaz, and Vaz, 2021; Zhang, Zhao, and Yu, 2020), and regulatory volatility further compels firms to adopt adaptive, rather than fixed, integration strategies (Eltayeb, Elkadi, and Ali, 2021; Zhu and Sarkis, 2019). Together, RBV and contingency theory explain both why SCI matters (RBV) and why its effect may vary across the specific dimensions tested in this study (contingency theory).

2.7. Hypotheses Development

Building on the foregoing review, the following hypotheses are proposed and tested:

- **H1:** Internal integration has a significant positive effect on the operational efficiency/performance of renewable energy organisations in Lagos State.
- **H2:** Supplier integration has a significant positive effect on the energy output and capacity utilisation of renewable energy organisations in Lagos State.
- **H3:** Customer integration has a significant positive effect on customer satisfaction/organisational performance of renewable energy organisations in Lagos State.
- **H4:** Overall/strategic supply chain integration has a significant positive effect on the organisational performance of renewable energy organisations in Lagos State.
- Figure 1 presents the conceptual framework guiding the study, linking the four SCI dimensions to organisational performance, moderated by organisational size and the regulatory/infrastructural context.



(Source: Author)

Figure 1 Conceptual framework of the study

3. Methodology

3.1. Research Design and Philosophy

The study adopted a positivist research philosophy and a quantitative, cross-sectional survey design, consistent with the objective of testing pre-specified hypotheses about measurable relationships between SCI dimensions and organisational performance. A deductive approach was used: hypotheses derived from the literature were tested against primary data rather than generated inductively from the data itself.

3.2. Population, Sample, and Sampling Technique

The target population comprised 150 employees and managers across four branches of two renewable energy organisations operating in Lagos State (branch sizes of approximately 30 and 45 employees, respectively). A sample of 100 respondents — spanning junior and senior staff across operational, procurement, and customer-facing functions — was drawn using a combination of stratified and simple random sampling, to ensure proportional representation across staff cadres while giving every eligible employee within each stratum an equal chance of selection.

3.3. Instrumentation and Measurement

Data were collected using a structured, self-administered questionnaire comprising two sections: Section A captured respondent demographics (gender, age, education, marital status, staff cadre), and Section B measured the four SCI dimensions and organisational performance using five-point Likert-type items (1 = strongly disagree, 5 = strongly agree). The instrument was reviewed for content validity prior to administration, and confidentiality and anonymity were assured throughout.

3.4. Data Analysis

Data were analysed in SPSS 23 using descriptive statistics (frequencies, means, standard deviations) to profile respondents and summarise construct-level agreement, and inferential statistics — Pearson correlation and simple linear regression — to test each hypothesis. Because the four SCI dimensions are conceptually and empirically correlated, each was regressed individually against organisational performance, consistent with the study's hypothesis-by-hypothesis testing strategy; a composite "overall SCI" score was additionally regressed against performance to capture the aggregate effect (H4). The general form of the estimated model is:

$$OPF = \beta_0 + \beta_k \cdot SCI_k + \varepsilon \quad (k = \text{internal, supplier, customer, or overall integration})$$

where OPF denotes organisational performance and SCI_k denotes the SCI dimension being tested.

3.5. Ethical Considerations

Participation was voluntary, and respondents were informed of the study's purpose before completing the questionnaire, satisfying informed consent. No personally identifying information was collected, and responses were stored securely and used solely for academic purposes, in line with standard human-subjects research ethics.

4. Results

4.1. Respondent Profile

Table 1 summarises the demographic profile of the 100 respondents. The sample was fairly balanced by gender (58% male, 42% female) and predominantly young, with 57% aged between 21 and 30 years. Respondents were well educated: 43% held an HND/B.Sc./BA, 18% held a Master's-level qualification, and 2% held a doctorate. Most respondents (74%) were single, and staff cadre was close to evenly split between junior (58%) and senior (42%) roles.

Table 1 Demographic profile of respondents (N = 100) (Source: Author's field survey)

Variable	Category	Frequency	Percent
Gender	Male	58	58%
	Female	42	42%
Age (years)	Below 21	4	4%
	21–30	57	57%
	31–40	25	25%
	41–50	10	10%
	Above 50	4	4%
Education	HND / B.Sc. / BA	43	43%
	M.Sc. / MBA / MA	18	18%
	OND	17	17%
	WASSCE	17	17%
	Ph.D.	2	2%
	Other	3	3%
Marital status	Single	74	74%
	Married	23	23%
	Separated / Divorced / Widowed	3	3%
Staff cadre	Junior staff	58	58%
	Senior staff	42	42%

4.2. Descriptive Statistics of Study Constructs

Table 2 reports the mean and standard deviation of respondent agreement with statements measuring each SCI dimension. All constructs returned mean scores above the scale midpoint of 3.5, indicating general agreement that integration practices are present within the sampled organisations. Internal integration recorded the highest construct mean (4.35), driven by strong agreement that firms share real-time supply-and-demand data across departments (M = 4.72, SD = 0.83). Supplier integration averaged 4.20, with open communication with key suppliers rated most highly (M = 4.62, SD = 0.87), while supplier involvement in production forecasting was comparatively lower (M = 3.94, SD = 0.84) — the weakest-rated item overall and a marker of where integration remains least mature. Organisational performance items averaged 4.17, with resource efficiency in converting inputs to finished output rated highest (M = 4.57).

Table 2 Descriptive statistics of study constructs (Source: Author's field survey)

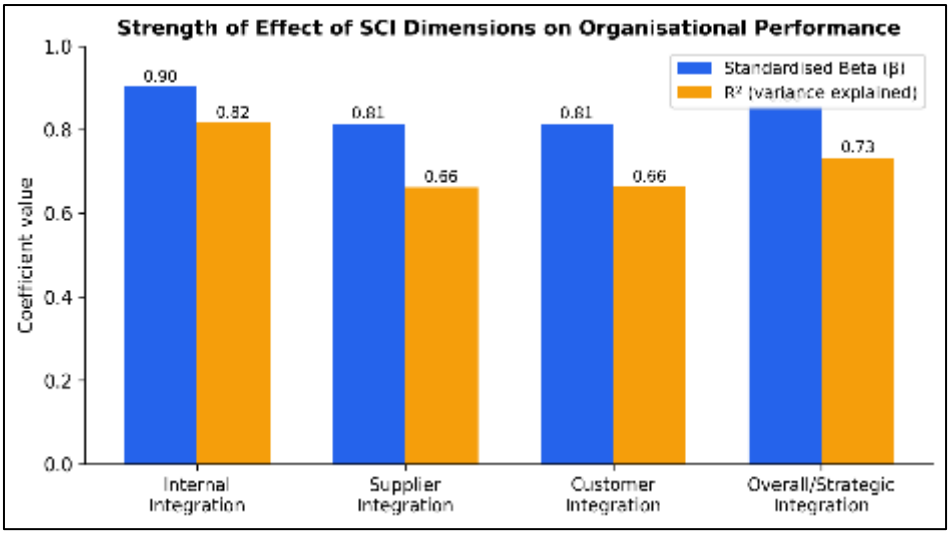
Construct	Representative indicator	Mean	SD
Internal Integration	Real-time supply/demand data shared across departments	4.72	0.83
	Seamless communication across management levels	4.39	0.67
	Swift response to market changes	4.32	0.63
	Coordination across procurement, production, distribution	4.11	0.83
	Construct mean	4.35	—
Supplier Integration	Open communication with key suppliers	4.62	0.87
	Suppliers involved in planning/forecasting	3.94	0.84
	Joint work on quality and lead-time reduction	4.07	0.71
	Market/demand information shared with suppliers	4.19	0.79
	Construct mean	4.20	—
Organisational Performance	Resource efficiency (input-to-output conversion)	4.57	—
	Facility output / capacity utilisation	3.96	—
	On-time employee task completion	4.02	—
	Customer satisfaction with service quality	4.12	—
	Construct mean	4.17	—

4.3. Hypothesis Testing

Table 3 summarises the correlation and regression results for each hypothesis. Internal integration was strongly and significantly associated with organisational performance (R^2 = .816, β = .903, B = .767, t = 20.838, p < .001), such that a one-unit increase in internal integration was associated with a 0.767-unit increase in performance, supporting H1. Supplier integration was also significantly related to performance (R^2 = .662, F(1,98) = 192.24, p < .001), supporting H2. Customer integration showed a significant positive effect (B = .825, β = .814, t = 13.87, p < .001), supporting H3. Finally, overall/strategic SCI significantly predicted organisational performance (R^2 = .733, F(1,98) = 268.41, p < .001), supporting H4. All four hypotheses were therefore accepted, with internal integration exerting the largest standardised effect and supplier integration the smallest, among a set of uniformly strong relationships (Figure 2).

Table 3 Summary of correlation and regression results for H1–H4. [a]R^2 for H3 estimated as β^2 given the simple bivariate specification. (Source: Author's SPSS output)

H#	Predictor → Organisational Performance	B	β	R^2	Adj. R^2	F	Sig.
H1	Internal Integration	.767	.903	.816	.814	434.21	<.001
H2	Supplier Integration	—	—	.662	.659	192.24	<.001
H3	Customer Integration	.825	.814	.663[a]	—	—	<.001
H4	Overall / Strategic Integration	—	.856	.733	.730	268.41	<.001



(Source: Author)

Figure 2 Standardised beta coefficients and R^2 values by SCI dimension

5. Discussion

The finding that internal integration exerted the strongest effect on organisational performance (R^2 = .816) is consistent with the view that internal alignment is a precondition for effective external integration (Ivanov and Dolgui, 2020; Fernandez and Hazen, 2021): firms cannot coordinate meaningfully with suppliers or customers if information does not first flow efficiently across their own functions. The high mean agreement with real-time data sharing (M = 4.72) suggests that the sampled renewable energy firms have already invested in the communication infrastructure underpinning this result, echoing Wang, Cao, Bai, Jia, and Li's (2020) observation that operationally integrated firms achieve superior efficiency through real-time visibility.

The significant but comparatively smaller effect of supplier integration (R^2 = .662) aligns with the descriptive findings: while communication with suppliers was rated highly, supplier involvement in forecasting and production planning was the weakest-rated practice in the survey. This pattern is consistent with Jacobs, Swink, and Linderman's (2021) argument that trust and long-term commitment — rather than communication alone — are what convert supplier relationships into capacity gains, and it suggests that Lagos-based renewable energy firms have engaged suppliers operationally but not yet strategically, echoing case-based evidence that African renewable energy firms often achieve internal unification well ahead of external supplier integration (Carvalho, Ramos, Vaz, and Vaz, 2021).

Customer integration's significant effect (β = .814) supports the argument that structured use of customer feedback improves service responsiveness and, by extension, performance (Wu, Liu, and Zhong, 2021; Li, Liu, Zhang, and Li, 2020). Given the reliability-sensitive nature of energy services, this finding underscores the practical value of treating customer feedback as an operational input rather than a peripheral marketing function.

Finally, the strong effect of overall/strategic integration (R^2 = .733) supports the proposition that SCI dimensions operate cumulatively: firms that align internal, supplier, and customer integration under a coherent strategic umbrella achieve performance gains beyond what any single dimension delivers in isolation (Beske and Seuring, 2023; Chen, Zhao, and Han, 2022). Read through a contingency lens, this result also reflects Nigeria's specific institutional context: because infrastructural gaps and regulatory uncertainty constrain what firms can achieve through any single integration channel, strategic coordination across all channels becomes the more reliable route to performance (Molina-Azorin et al., 2020; Eltayeb, Elkadi, and Ali, 2021; World Bank Group, 2021). Collectively, these findings extend SCI theory — developed predominantly in manufacturing and banking contexts — into an emerging-market renewable energy setting, showing that the same broad relationships hold, but with a distinct ordering of effect sizes shaped by local supply chain maturity.

6. Conclusion

This study examined the effect of supply chain integration on the performance of renewable energy organisations in Lagos State, Nigeria, disaggregating SCI into internal, supplier, customer, and strategic dimensions. Using survey data from 100 employees and managers, the analysis found that all four dimensions exert a statistically significant, positive effect on organisational performance, with internal integration showing the strongest relationship and supplier integration the weakest — though still substantial. These results confirm that supply chain integration is not merely a manufacturing-sector concern but a material driver of performance in Nigeria's renewable energy industry, and that its dimensions, while related, contribute unevenly, with internal alignment and strategic coordination currently offering the greatest returns.

Recommendations

Four recommendations follow from these findings. First, renewable energy firms should invest in centralised data-management platforms and staff training to sustain the real-time information flows already driving strong internal-integration performance. Second, given that supplier integration lagged other dimensions — particularly supplier involvement in forecasting — firms should move beyond transactional supplier communication towards joint planning mechanisms such as vendor-managed inventory and shared demand forecasts. Third, firms should formalise the use of customer feedback in service-delivery decisions, for example through structured feedback loops and service-recovery protocols, to convert existing customer-integration gains into sustained satisfaction. Fourth, management should institutionalise strategic alignment mechanisms — cross-departmental planning meetings, shared performance metrics, and a clearly communicated strategic vision — so that internal, supplier, and customer integration efforts reinforce one another.

Theoretical and Practical Implications

Theoretically, the study extends RBV and contingency theory into an emerging-market renewable energy context, showing that integration capabilities function as firm-specific resources whose returns are shaped by Nigeria's regulatory and infrastructural environment. Practically, it offers renewable energy managers and Nigerian energy-sector policymakers an evidence base for prioritising integration investment, particularly in supplier-facing processes.

Limitations and Future Research

The study is limited by its focus on two organisations in a single state, which constrains generalisability, and by its reliance on simple bivariate regressions rather than a multivariate model that could disentangle the shared variance among the four SCI dimensions. Future research should employ multivariate or structural equation modelling across a larger, multi-regional sample, and could usefully incorporate qualitative methods to capture the relational and managerial dynamics that quantitative measures alone cannot reveal.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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